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ABSTRACT

The history of attempts by psychologists to determine the contribution of personality to intelligence has not been one of unqualified success. Part of the problem may be in the balance of granularity of analyses on the intelligence side and the personality side. A comprehensive analysis of the contributions of extraversion and neuroticism to problem solving latency, accuracy, and persistence in stressed and unstressed conditions was undertaken. Two directional predictions were made based on previous research: (1) Solution-time will be shorter in extraverts than ambiverts or introverts, and shorter in ambiverts than introverts, in both stressed and unstressed conditions. (2) Neuroticism will be related to solution-time such that in the stressed condition, mid-neuroticism subjects will be faster than either high- or low-neuroticism subjects who will not be different from each other, and in the unstressed condition high-neuroticism subjects will be faster than mid-neuroticism and low-neuroticism subjects, and mid-neuroticism subjects will be faster than low-neuroticism subjects. Subjects were university students in undergraduate and graduate educational psychology classes. The personality dimensions of extraversion-introversion and neuroticism were measured by Form A of the Eysenck Personality Inventory (EPI). The dependent variables of problem-solving latency, accuracy, and persistence were measured by the Nufferno Tests. Results are discussed in relationship to previous studies. (Author/BJG)

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INTELLIGENCE AND PERSONALITY REVISITED:

AN EXPERIMENTAL APPROACH

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Intelligence and Personality Revisited: An Experimental Approach

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The history of attempts by psychologists to determine the contribution of personality to intelligence has not been one of unqualified success. Part of the problem may lie in the balance of granularity of analyses on the intelligence side and the personality side. Intelligence has typically been defined in global terms usually consisting of an I.Q. score, while personality has been defined as a set of traits. These traits have then typically been correlated with the intelligence score in an attempt to identify which traits or cluster of traits are significantly associated with it. Thus, on the personality side a relatively fine grained analysis of individual differences has been entered into the comparison, while on the intelligence side a much more gross analysis has been used. When significant correlations are found, they are difficult to interpret in other than extremely atheoretical-applied-predictive terms. That is, this or that personality trait was predictive of a global I.Q. measure. The theoretical implications were unclear, primarily because the I.Q. construct was itself a

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technological rather than psychological one, in that it was not generated from theoretical considerations as to how and in what differentiable ways cognitive processes were operating. Even when simple correlations were obtained between an I.Q. score and personality variables, few more sophisticated procedures such as moderator variable analyses (Saunders, 1956) were undertaken. Not only were theoretical analyses of intellective processes lacking, but much of the personality analysis was without theoretical basis, that is, theoretical implications of the personality variables for cognitive functioning were not drawn. Many studies were simple empirical searches for statistically significant relationships. It is here argued that this lack of theoretical orientation has in part been responsible for our present day ignorance on how personality and intellective functioning are related. In studies that have undertaken more fine-grained analyses of intelligence, such as including separate indices of verbal ability, spatial ability, reasoning ability, and so on, a significant problem has been that the processes involved in successful scores remain obscured, and it is the identification of such processes with theoretically related personality processes that would seem to be at the heart of successfully concatenating personality and intelligence.

One attempt to systematically identify the processes involved in the assessment of intelligence is that of Furneaux (1961). He has suggested that there are three main determinants of score in intellective assessment. These three putatively independent factors are mental speed, accuracy (error-checking mechanism),

and persistence. Mental speed, a direct descendant of Galton's notion, is the central cognitive process. More recent evidence for the significance of "mental speed" as a cognitive process has been provided by Roth (1964) and Jensen (unpublished) who have demonstrated highly significant regressions of speed of information processing in a complex reaction time task on intelligence test performance. In addition, some evidence that latency of the cortical evoked response is significantly related to intelligence, as measured by traditional tests, has been reported by Ertl and Schafer (1969), although Davis (1971) has reported data not supporting this relationship. Furneaux (1953) has argued that these three fundamental cognitive processes of speed, accuracy and persistence are not appropriately measured by traditional intelligence tests, the three often being confounded, and has developed his own measures that attempt to differentiate among them. He has contended that the fundamental unit of analysis must be the test item, rather than the total score derived from a psychometric measure. Furneaux (1952) demonstrated that in order to obtain speed measures uninfluenced by other factors, one at least needed to time every item in the test and then use only the speed of correct solutions in obtaining the score. He argued (1961) that ". . . the addition of time data relating to incorrectly solved problems to that derived from correct solutions gave rise to a score which actually had a higher standard error of measurement than the score derived from the correct solutions only." Interestingly, Slater (1938),

employing latency of correct solutions, had demonstrated that a marked variance in mental speeds could be found within groups having a relatively small variance in score on a standardized intelligence test.

One variable which would be expected to affect the speed of solution time is the difficulty of test problems. The difficulty of a problem traditionally has been scaled in terms of the number of individuals in a defined group who fail to achieve an acceptable solution. However, Furneaux (1955) advocated that problems can only be classified in terms of the differences in response characteristics which they evoke. Accordingly, he asserted that for the adequate analysis of speed, item difficulty should be scaled relative to the time taken to achieve the satisfactory response. Furthermore, for pure speed measures uncontaminated by other factors, a test should use rather easy items of approximately equal difficulty.

The second component of Furneaux's analysis of intellective process is that of accuracy. Accuracy usually refers to the number of items correctly solved. Eysenck (1967) identified accuracy with an "error-checking mechanism" defined as ". . . a mental set predisposing the individual to check his solution against the problem instead of writing it down immediately." Furneaux (1961) reported that accuracy measures usually demonstrated a higher correlation with scores on conventional intelligence and cognitive tests than speed and persistence measures. There have been few cognitive tests designed to provide adequate measures of accuracy. Like speed measures,

accuracy scores on the traditional type of intelligence test usually are contaminated by many other factors, such as guessing, abandonment, and so on. Furneaux (1955) demonstrated that accuracy was directly related to difficulty level and time allowed for completion of the test. He suggested that an unambiguous accuracy score should be obtained using problems at a difficulty level below the point at which the subject is unable to correctly solve and tends to abandon; however, if the problems used are too easy, then few subjects would produce incorrect answers, and an unsatisfactory response distribution would be obtained. Such a measure, if appropriately constructed, could provide an uncontaminated measure of both accuracy and speed. Furneaux's attempt to develop such measures will be described below.

The third component of Furneaux's analysis of intellective process is that of persistence. This is defined as the duration of time a subject continues to work on an unsolvable item in an intelligence or cognitive test administered with no time limit (Furneaux, 1961). Substantial correlations between persistence and cognitive test scores have been reported by Furneaux (1952, 1953), Hofstaetter (1954) and Mangan (1954). It seems intuitively obvious that individuals abnormally lacking in persistence, as defined, would obtain reduced scores on most intelligence and cognitive tests. As persistence is measured on insolvable test items, there are some technical difficulties in measuring it, with no perfect solution yet having been offered (Furneaux, 1961; Payne, Matussek & George, 1959). For example, Payne, Matussek

and George (1959) attempted to measure the persistence of mental patients on unsolvable problems. The test was administered individually and all patients were told not to discuss it with anyone else. After several patients had taken the test, however, the next refused to do it, saying that he had learned from other patients that is was unsolvable. Furneaux (1953) recommended that test instructions be designed to ensure high motivation so that subjects would continue with problems found to be "difficult" rather than give them up easily.

As stated earlier, Furneaux's three factor model represents an attempt to systematically identify the processes involved in cognitive test performance and provides a potentially useful framework for research into the contribution of personality to intelligence. Some attempts to delineate the role of personality in the processes of mental speed, accuracy and persistence using Furneaux's (1955) tests of the latter have been reported. All of these studies have been derived on the personality side from the theory of Eysenck (1957) which identifies three super-factors in the measured personality domain--extraversion-introversion, neuroticism and psychoticism. These personality dimensions are held to be pervasive ones accounting for more personality variance than any other set of dimensions. Where at least the first two are concerned, there is considerable evidence to support their significance in the analysis of personality (Wiggins, 1968).

Of particular interest to the study of personality-intelligence relationships however is the feature that there is a considerable body of psychological theory underlying these dimensions. That is, theoretical implications of extraversion and neuroticism for processes of learning, cognition, perception and sensation have been outlined (Eysenck, 1957, 1970). Thus there is in at least outline form a theory of personality that has implications for cognitive processes that can serve as a guide to research on personality contributions to mental speed, accuracy and persistence.

In 1947, Eysenck suggested that on a measure of speed, extraverts would tend to be fast and introverts slow. The reasoning for such a result, according to Eysenck's (1957) theory, was that introverts build-up reactive inhibition more slowly and are therefore more easily conditioned than extraverts, it follows that introverts compared to extraverts would have acquired more distracting conditioned responses (e.g., the obsessional tendency to check and recheck their answers) to their anxiety in the test situation. Consequently the introverts' responses would be slower than the extraverts. Where neuroticism is concerned, treating this variable as equivalent to anxiety it would be expected from the Yerkes-Dodson (1905) principle that performance on the speed measures of Furneaux would bear an inverted U relationship to neuroticism when the speed measures were administered under stressed conditions (Farley, 1966; Lynn & Gordon, 1961; Payne, 1961). The combination of high neuroticism and experimentally generated anxiety (time stress) would be expected to interfere with effective performance. However, mid neuroticism and experimental anxiety would be expected

to facilitate performance over a combination of low neuroticism and experimental anxiety. Under unstressed conditions neuroticism would be expected to have a linear facilitating effect on speed across the range of neuroticism values.

There is moderate evidence for a linear relationship between extraversion and speed, with extraverts faster than introverts, using the pure speed measure developed by Furneaux (Farley, 1966). The situation is comparable where neuroticism is concerned. Farley (1966) found evidence for an inverted-U shaped relationship of neuroticism to speed under time-stress conditions. Remaining studies (Berger, cited by Eysenck, 1967; Furneaux, 1961; Payne, 1961) are generally equivocal in that analyses were based on combined extraversion and neuroticism scores rather than determining the separate contribution of each measure. Where accuracy is concerned, it has been hypothesized that introverts perform more accurately than extraverts, on the argument that 1) introverts have an obsessional tendency to check and recheck their answers (Payne, 1961) and 2) extraverts tend to be more impulsive and careless than introverts (Eysenck, 1970; Farley, 1970). Support for this prediction using Furneaux's measures has been provided by Furneaux (1956), whereas Farley (1966) reported no significant relationship between accuracy and personality (extraversion and neuroticism). One problem in evaluating data on both speed and accuracy lies in any possible relationship between the two. Although it seems reasonable to expect a relationship between speed and accuracy such that an increase in speed may be attended

by a decrease in accuracy, there is little supportive evidence. Furneaux (1961) stated that he knew of no evidence for such a relationship. On the basis of the Farley (1966) and Furneaux (1956) studies above, it would appear that the evidence for a relationship of extraversion and neuroticism to accuracy is equivocal.

With regard to persistence there are no personality studies bearing on Furneaux's analysis or using his measures of persistence. However, there is research from other sources that would suggest greater ideational persistence of introverts over extraverts (Eysenck, 1959; Lynn & Gordon, 1961). There is some slight evidence that neuroticism is not related to persistence (Lynn & Gordon, 1961).

The research reviewed above indicates that extraversion and neuroticism may contribute in varying degrees to cognitive speed, accuracy and persistence. However, few relevant studies are available, and very few bear directly on Furneaux's model using his measures of the three factors (none use all three measures in one study).

Furneaux's study on the cognitive-intellective side and Eysenck's on the personality side seem promising for the study of personality-intelligence relationships. However, the work to date that has considered them together has been piece-meal, in that both personality dimensions and all three cognitive measures, as well as a stress versus non-stress condition, have not been studies in the same experiment.

It was the purpose of the present study to undertake a comprehensive analysis of the contributions of extraversion and neuroticism to problem solving latency, accuracy and persistence in stressed and unstressed conditions.

Two directional predictions were made based on previous research:

1. Solution-time will be shorter in extraverts than ambiverts (Ss intermediate between extravert and introvert) or introverts, and shorter in ambiverts than introverts, in both stressed and unstressed conditions.
2. Neuroticism will be related to solution-time such that in the stressed condition, mid-neuroticism Ss will be faster than either high-or low-neuroticism Ss who will not be different from each other, and in the unstressed condition high-neuroticism Ss will be faster than mid-neuroticism and low-neuroticism Ss, and mid-neuroticism Ss will be faster than low-neuroticism Ss.

Although no further research-based directional predictions than the above are offered, the purely theoretical considerations discussed in the introduction would lead to the following expectations: 1) accuracy will be greater in introverts than ambiverts and extraverts, and greater in ambiverts than extraverts in both "stressed" and "unstressed" conditions, 2) extraverts will be significantly less persistent than ambiverts and introverts, 3) solution-time and accuracy will be significantly negatively related, 4) accuracy and persistence will be significantly positively related, 5) solution-time and persistence will be significantly negatively related.

Method

Subjects

Ninety-six university students (61 females, 35 males; mean age = 21.4 years) in undergraduate and graduate educational psychology classes were tested in the experiment. Sample size was based on some preliminary computations of statistical power. With 96 Ss in a 3 (three levels of personality) x 2 (stressed vs. unstressed test administration) factorial design, it was determined that sufficient power would be available to detect differences under the major hypotheses concerned with personality differences, using F-tests conducted with $\alpha = .10$ (see justification in Results section) followed by Scheffé post-hoc comparisons at the same alpha level.

Design

The basic designs consisted of a series of two-way analyses of variance in factorial designs, and correlational analyses. Simple personality effects on the three dependent variables within each of the unstressed and stressed treatment as well as personality by treatment interaction effects were first analyzed. Then, the relationships among solution-time, accuracy and persistence were considered in correlational analyses.

Materials

Personality dimensions of extraversion-introversion and neuroticism were measured by Form A of the Eysenck Personality Inventory (EPI; Eysenck & Eysenck, 1963). This inventory contains 57 self-report true-false items, 24 scored for extraversion, 24 for neuroticism, and 9 validity or lie scale items. Farley (1971)

has summarized stability estimates for the extraversion and neuroticism scales on American, Australian and British samples of .78 to .97. Stability estimates for the lie scale ranged from .50 to .78. The two dimensions of extraversion and neuroticism as measured by the EPI have repeatedly been shown to be uncorrelated (Farley, 1967, 1968), and extensive validity data have been reported (Eysenck, 1970).

The dependent variables of problem-solving latency, accuracy and persistence were measured by the Nufferno Tests (Furneaux, 1955). These tests employ Thurstone-type letter series items. The Speed tests provide measures of speed and accuracy, while the Level tests provide assessment of persistence interacting with speed and accuracy. Several different forms of the Speed and Level tests have been developed, principally for use with different age groups. Form B(1) of the Speed test and Form GL/2C .46 of the Level test were used in the present study. The former test is reported (Furneaux, 1955) to be satisfactory for both speed and accuracy measurement for Ss of mental age 13 years and above, while apparently the latter test was designed for use with adults of I.Q.s in the range 100-200, and "was particularly adapted for providing good discrimination within superior groups." The tests used were revised slightly for the present purpose. Four unsolvable items were added to the other ten items selected from the Level test to provide an adequate measure of persistence.

In this study, the Speed test consisted of 20 letter series items of equal difficulty. The persistence test (derived from the Level test) consisted of 14 letter series items, four of which (nos. 5, 8, 11, 14 in the series) were unsolvable. These four items were designed to provide a pure measure of persistence. The remaining 10 items were relatively easy and solvable, and were included in the test to attempt to prevent the S from detecting the four unsolvable items and to alleviate possible anxiety and frustration which may be generated by the unsolvable items.

Scoring of the "revised" Nufferno tests produced a speed score, an accuracy score and a persistence score. The speed score was computed as the mean log time a S spent achieving correct answers to each item; solution-time for incorrectly solved items was ignored. The accuracy score was simply the total number of items a S correctly solved out of the 20 items. Finally, the persistence score was computed as the mean log time a S spent on the unsolvable items.

Procedure

Each S was individually administered the "revised" Nufferno tests followed by the EPI. Upon entering the interview room Ss were randomly assigned to either the "stressed" or "unstressed" treatment for the Speed portion of the Nufferno tests. Instructions were given to the S in written form with simultaneous auditory presentation of instructions by tape recorder. In the unstressed speed testing, the S was simply told to work at his own rate. [However, covert recording of the time S spent in responding to each item was recorded by E through use of a microtimer in an

adjacent room controlled by E through a (hidden) remote switch.] The E sat across a table from S. In the stressed speed testing, the S was instructed to work as quickly as he could. He was also told that his solution-time would be recorded to every individual test item. In addition, two relatively audible electric timers were placed between E and S, ostensibly for time recording, but primarily to induce time-stress. Each test item on the Speed test was mounted on a 5 in. x 8 in. card and presented one at a time to S. The S's response sheet consisted of 20 locations for answers to the problems. Solution-time was measured as the time from presentation of a problem card (item) to the point when S put pencil to paper to record his answer. Where the persistence test was concerned, a slightly different procedure was employed. Here the S did not know how many test items would be presented. The 5 x 8 problem cards were kept out of S's sight except for the one being worked on at the moment, and S's response sheet did not contain information indicating the total number of problems to be solved. The instructions for the persistence test were deliberately designed to encourage the S to spend as much time as he needed for each item. Recording of time spent on each problem was accomplished using the same procedures as in the unstressed condition of the Speed test. A maximum time of 10 minutes per item was allowed for the persistence test. After a S had spent 10 minutes attempting to solve an item, he was instructed to proceed to the next item. This happened in very few cases. All timing was to 1/1000 of a minute.

The order of testing was Speed test followed by the Persistence test, with a three minute interval between performance on the two tests, followed five minutes later by EPI testing. The latter testing was undertaken in a different room from the problem-solving assessment.

Data Analysis

No test protocols were scored until the termination of the experiment. In analyzing EPI results, Ss were divided into three groups on each of the extraversion-introversion and neuroticism scales, using percentile cut-off points of 30 and 70, following recommendations of Eysenck and Eysenck (1963). [Such a method also allows for equal SDs for groups on either side of the 50th percentile, with the latter value being used in any construction of groups utilizing both personality dimensions (see below).] The foregoing procedure yielded three groups--extraverts, ambiverts, introverts--for the extraversion-introversion dimension, and--high-neuroticism, mid-neuroticism and low-neuroticism Ss--for the neuroticism dimension.

Another data analysis based on EPI results used a combination of the extraversion and neuroticism dimensions in constructing S groups for comparison. The extraverts consisted of those Ss with scores above the 50th percentile, and the introverts with scores below the 50th percentile. The 50th percentile was likewise used in constructing the high-neuroticism (labile) and low-neuroticism (stable) groups. These groups were then combined together into four groups labeled labile-extraverts, labile-introverts, stable-extraverts and stable-introverts.

In the main data analysis, the groups described above were compared on the three dependent measures of problem-solving latency, accuracy and persistence in the two experimental conditions of stressed vs. unstressed testing.

Results

The mean extraversion-introversion score for the 96 Ss was 12.11 (SD = 4.12); the comparable neuroticism mean was 9.44 (SD = 4.60). These values are close to those for a sample of American college students reported by Farley (1971). Although a total of 99 Ss had been originally tested in the experiment, 3 were removed from the data analysis because of EPI lie scale scores of 6 or greater [using the cut-off point recommended by Eysenck & Eysenck (1963) in the EPI manual].

Where extraversion was concerned, the use of 30th and 70th percentile points in constructing three personality levels yielded Ns of 18, 18 and 12 for extraverts, ambiverts and introverts respectively in the unstressed condition, and Ns of 11, 21 and 16 for extraverts, ambiverts and introverts, respectively, in the stressed condition. The extraversion means, and SDs in parentheses, for each of the foregoing six groups were 17.39 (1.79), 12.56 (1.38), 7.08 (2.15), 16.55 (1.86), 11.33 (1.34) and 7.50 (1.41) respectively.

Where neuroticism was concerned, the use of 30th and 70th percentile points in constructing three personality levels yielded Ns of 12, 16 and 20 for high-neuroticism, mid-neuroticism and low-neuroticism groups, respectively, in the unstressed condition, and Ns of 19, 14 and 15 for high-neuroticism, mid-neuroticism and low-neuroticism groups, respectively, in the stressed condition.

The neuroticism means, and SDs in parentheses, for each of the foregoing six groups were 14.33 (2.35), 9.56 (1.21), 4.40 (2.06), 14.95 (2.30), 9.71 (1.20) and 4.93 (2.09) respectively.

In combining the extraversion and neuroticism dimensions so as to form four personality groups, Ss were first divided into extravert and introvert groups at the 50th percentile--12.01--on the extraversion scale, and into labile and stable groups at the 50th percentile--9.00--on the neuroticism scale. The resulting Ns in these groups were 51 for extraverts, 45 for introverts, 47 for the labile group and 49 for the stable group. These Ss were then re-assigned into quadrants of labile-extravert, labile-introvert, stable-extravert and stable-introvert. The resultant Ns in each of these four groups for the unstressed and stressed conditions were, respectively, 11, 9, 20, 8, 10, 17, 10 and 11. The mean extraversion scores, with SDs in parentheses, for the foregoing eight groups were 16.90 (2.77), 8.00 (3.04), 14.95 (2.19), 8.38 (1.92), 15.10 (2.23), 8.88 (1.45), 15.50 (2.54) and 8.36 (2.20). The comparable neuroticism means, and SDs, were 13.36 (2.25), 13.44 (3.00), 5.20 (2.67), 6.50 (2.20), 14.80 (2.86), 13.00 (2.60), 6.40 (1.51) and 5.54 (3.05).

Latency Analysis

In Table 1 are found the mean log latencies for the extravert, ambivert and introvert groups under the unstressed and stressed conditions.

Insert Table 1 about here

The foregoing data of Table 1 were analyzed by least-square

procedures due to the unequal cell frequencies. A 3 (extraversion levels) x 2 (experimental treatments) factorial design was adopted to test for effects due to the combined simple effects of extraversion within treatments and the extraversion x treatment interaction (Marascuilo & Levin, in preparation). In order to keep the total α comparable to that of a traditional analysis, this residual source of variance was tested with $\alpha = .10$. Significant effects due to extraversion were detected ($F = 3.27$, $df = 4/90$, $p < .05$). Scheffé post-hoc pair-wise comparison procedure ($\alpha = .05$) was employed to identify reasons for rejection. This analysis indicated that extraverts were significantly faster than introverts in the unstressed condition.

In Table 1 are also found the mean log latencies, and SDs, for the high-, mid- and low-neuroticism groups in the unstressed and stressed conditions. The foregoing data of Table 1 were analyzed in a comparable manner to those for extraversion. No significant effects attributable to neuroticism were obtained ($F < 1$).

The mean log latencies, and SDs, for the labile-extraverts, labile-introverts, stable-extraverts and stable-introverts in the unstressed and stressed conditions are also presented in Table 1. These data were analyzed like those for extraversion and neuroticism treated separately. Significant effects due to personality were found ($F = 2.75$, $df = 6/88$, $p < .05$). Scheffé post-hoc comparisons indicated that labile-extraverts were significantly faster than stable-introverts in the unstressed condition, and stable-introverts were significantly faster than labile-introverts in the stressed condition.

Accuracy Analysis

In Table 2 are located the means and SDs for the accuracy scores of the extravert, ambivert and introvert groups in the unstressed and stressed conditions.

Insert Table 2 about here

The data of Table 2 were analyzed as above. No significant effects of extraversion were found (F = 1.02, df = 4/90, p > .10).

In Table 2 are also presented the means and SDs for the accuracy scores of the high-, mid- and low-neuroticism groups in the unstressed and stressed conditions. These data were analyzed as above. No significant effects of neuroticism were obtained (F < 1).

In Table 2 are also presented the means and SDs for the accuracy scores of the labile-extravert, labile-introvert, stable-extravert and stable-introvert groups in the unstressed and stressed conditions. The foregoing data of Table 2 were analyzed as above. No significant effects attributable to personality were found (F = 1.41, df = 6/88, p > .10).

Persistence Analysis

The means, with SDs and Ns in parentheses, of the log persistence scores for the extraverts, ambiverts and introverts were 0.3865 (SD = 0.2178, N = 29), 0.4522 (SD = 0.2878, N = 39) and 0.4272 (SD = 0.2525, N = 28), respectively. (It should be kept in mind that the persistence data were all obtained under unstressed conditions, therefore there is no stressed vs. unstressed comparison here.) These data were subjected to a one-way analysis of variance with α set at .05. No significant extraversion effect was obtained (F < 1).

The means, with SDs and Ns in parentheses, of the log persistence scores for the high-neuroticism, mid-neuroticism and low-neuroticism groups were 0.3981 (SD = 0.2154, N = 31), 0.4594 (SD = 0.3094, N = 30) and 0.4195 (SD = 0.2451, N = 35), respectively. These data were also analyzed in one-way analysis of variance with $\alpha = .05$. No significant neuroticism effect was obtained ($F < 1$).

The means, with SDs and Ns in parentheses, of the log persistence scores for the labile-extravert, labile-introvert, stable-extravert and stable-introvert groups were 0.4380 (SD = 0.2828, N = 21), 0.4374 (SD = 0.2827, N = 26), 0.4241 (SD = 0.2661, N = 30) and 0.3934 (SD = 0.1791, N = 19) respectively. These data were analyzed as above. No significant personality effect was obtained ($F < 1$).

Relationships Among Problem-Solving Latency, Accuracy and Persistence

The latency, accuracy and persistence scores were intercorrelated within the unstressed condition, and within the stressed condition (stressed where the Speed test was concerned, but with no stress in the persistence measurement), with Ns of 48 in each condition. The correlations in the unstressed condition were latency/accuracy r. = -.07 (NS), latency/persistence r. = .32 ($p < .05$), and accuracy/persistence r. = .15 (NS). The correlations in the stressed condition were latency/accuracy r. = .14 (NS), latency/persistence r. = -.17 (NS), and accuracy/persistence r. = .03 (NS). Clearly the measures tended to bear little relationship to each

other, with only the two time measures (latency/persistence) being significantly related (10 per cent shared variance) and only when the latency measure was obtained under the unstressed condition.

Discussion

The major hypothesis (prediction #1) concerning the relationship of extraversion and problem-solving latency was supported, with extraverts performing faster than introverts, although neither of these two groups differed significantly from ambiverts. The latter group's mean performance did however fall between the performance means of the former two groups, as predicted. Given that the present study was the most extensive attempt to relate personality to the three-factor model of intellective performance (Furneaux, 1961) using a measure of problem-solving time uncontaminated by other variables (e.g., accuracy, and so on), then it may be tentatively concluded that speed of generating the correct solution to a problem, as presently defined, is significantly greater in extraverted over introverted individuals. Interestingly, this tentative generalization is limited to a condition of testing without stress on speed of problem-solving. In the present results, when speed was stressed, no significant difference between extraverts and introverts was obtained. It might be hypothesized that in the unstressed condition the extraverts were functioning at or near their ceiling of problem-solving time, so that the time-stress instructions would have but slight effects on group mean solution-time, although they would be expected to markedly

narrow the score variance. Where introverts are concerned, the time-stress instructions would have more "room to act" because of the lower performance (slower mean solution-times) of these Ss when no time-stress is present. Thus the time-stress instructions would narrow the difference in mean solution-time between introverts and extraverts, to possibly (as at present) non-significant levels, and would reduce score variance also, although to a lesser extent than found among the extraverted Ss. Ambiverts would be expected to fall between the introverts and extraverts, both in the amount of increase in mean speed (more increase than extraverts, less than introverts) and in decrease in score variance (less than extraverts, more than introverts). To test the foregoing notion, differences scores were computed from Table 1 between the stressed and unstressed conditions, in means and SDs, for the three personality levels. Where mean changes from unstressed to stressed testing was concerned for extraverts, ambiverts and introverts respectively, values were .22, .26 and .36, indicating the least increase in speed for extraverts and the greatest for introverts, with ambiverts falling in between, thus supporting the foregoing ordinal prediction. Where comparable SD changes were concerned, the values were .08, .05 and .001, indicating the greatest reduction in variance for extraverts, the least for introverts, with ambiverts falling in between, thus supporting the foregoing ordinal prediction.

Where neuroticism and latency are concerned, the experimental predictions were not supported in that no significant effect of neuroticism was obtained. Indeed, the direction of means was

opposite to prediction where the stress manipulation was concerned, in that the curvilinear function predicted for the stressed condition was found (non-significantly) in the unstressed condition, whereas the linear function predicted for the unstressed condition was found (non-significantly) in the stressed condition. The lack of significant contribution of neuroticism is difficult to explain. If speed of problem-solving is indeed, as Furneaux (1961) has asserted, a function of drive, it may be important to measure drive through methods additional to EPI neuroticism. Eysenck (1967) has suggested that neuroticism scores represent a probability of responding with autonomic activation to an anxiety-producing situation. If a test situation was not perceived as anxiety-producing by the Ss, then the effect of differences in neuroticism would be reduced. This may be the reason for the present negative findings for speed and neuroticism--the situation may not have been significantly anxiety-producing to sophisticated college students in that there were no clear consequences of a S's test performance. It would be well in future research to more directly assess autonomic arousal through on-line real-time physiological measurement of blood volume, skin resistance and so on during the problem-solving tasks, and to insure that time-stress had significant consequences for a S's performance, such as adding instructions in this condition that indicated good (e.g., rapid) task performance would be considered when the student's grades in a course were being determined, etc. Perhaps the most parsimonious conclusion to draw at present is that, on the basis of this--the most extensive study to date--there is no reliable independent contribution of neuroticism to speed of problem-solving.

The main reason for the lack of contribution of personality to accuracy in unstressed testing is probably the ceiling effect found in this condition (see Table 2). Although no ceiling effect was found in the stressed condition, no personality effects were found either. Such negative results are not unexpected given the equivocal prior literature. Although the theory of personality and accuracy discussed in the introduction has gained no support from the present data, before one would consider the theory as infirmed, further empirical testing is probably required. For example, the test ceiling problem should be eliminated and the present study re-run. Of course, eliminating the test ceiling may be expected to lead to interactions with intelligence, so that items from two forms of the Furneaux Speed test (easy items) as well as Level test would be administered along with a traditional measure of intelligence.

Where persistence is concerned, previous studies (Furneaux, 1961; Payne, Matussek & George, 1959) have reportedly been unsuccessful in attempting to obtain direct measures of "intellectual persistence." The measure developed in the present study is the only available instrument to directly measure persistence in accord with Furneaux (1961) requirements for such measurement. However, no personality effects were obtained. The explanation of these negative findings could perhaps lie in 1) such college student volunteers might not be highly motivated to sustain particular efforts on the task, and 2) some of the Ss might have detected that certain items were in fact unsolvable and accordingly gave up their efforts due to this belief. The measurement of persistence

is the most ambiguous part of the assessment of the three dependent measures in Furneaux's theory. The present measure is the least ambiguous assessment used to date. It is suggested that Eysenck's theoretical analysis of personality contributions to persistence, at least as this latter variable was presently assessed, may be incorrect.

The expectations regarding the relationships among problem-solving latency, accuracy, and persistence were based on the assumptions that each of these factors bear a relationship to personality characteristics of extraversion and neuroticism. Since no significant differences in accuracy and persistence were attributable to personality, the present data did not demonstrate any significant relationships between latency and accuracy, or between accuracy and persistence. However, a positive relationship between speed and persistence in the unstressed condition was demonstrated. This correlation (.34) is comparable to that (.30) reported by Furneaux (1956). It is practically meaningful in that Ss who spent little time on solvable items also spent little time on unsolvable items. However, this statement should not be overgeneralized as the theory of persistence and personality was not supported by the same data.

Finally, the zone analyses consisting of comparisons of labile-extraverts, labile-introverts, stable-extraverts and stable-introverts were very helpful in elucidating the picture of personality contributions to the three-factor model of intellective assessment. Labile-extraverts, as expected, were faster than stable-introverts when tested without time-stress. However, stable-introverts also performed significantly faster than labile-introverts

under stressed testing. Thus, some contribution of neuroticism to speed is indicated but only among introverts, and this contribution is such that neuroticism impedes solution-time. This result agreed partially with that of Furneaux's study (1961). However, since the present data contains rather small sample size per group and heterogenous group variances, replication is recommended for further justification of this result.

In conclusion, the study supports the notion that personality effects on patterns of intellectual functioning can be demonstrated by experimental means. However, Furneaux's three factor model of cognitive performance is only partially supported by the present findings. His model has been heuristic in generating research relating components of intellectual functioning to personality. Whether the components proposed by Furneaux have discriminant validity has yet to be adequately established, and the precise ways in which they are related to personality are not yet clear.

Future research in this area should consider as a first priority the pursuit of answers to the following questions: a) how does mental speed relate to other aspects of personality and in what way is it represented or significant in other cognitive functions and processes, and b) how can accuracy and persistence be better conceptualized and measured? These latter two variables, especially, would seem to present difficult measurement problems, but their face validity as personality-relevant constructs reinforce their continued analysis in the study of personality and cognitive performance.

Table 1

Means and Standard Deviations of Log Latency Scores for the Various Personality Groups in the Unstressed and Stressed Conditions

Personality Group	Experimental Condition			
	Unstressed		Stressed	
	Mean	SD	Mean	SD
Extravert	-.6889	.1475	-.9103	.0710
Ambivert	-.6172	.1494	-.8770	.1036
Introvert	-.5205	.1314	-.8833	.1307
High-neuroticism	-.6368	.1407	-.8605	.0982
Mid-neuroticism	-.6097	.1439	-.8940	.1338
Low-neuroticism	-.6179	.1739	-.9132	.0841
Labile-extraverts	-.6850	.1168	-.8846	.0787
Labile-introverts	-.5752	.1316	-.8291	.1101
Stable-extroverts	-.6386	.1785	-.8951	.0731
Stable-introverts	-.5339	.1381	-.9701	.0992

Table 2

Means and Standard Deviations of Accuracy Scores for the Various Personality Groups in the Unstressed and Stressed Conditions

Personality Group	Experimental Condition			
	Unstressed		Stressed	
	Mean	SD	Mean	SD
Extravert	18.944	1.110	15.727	2.412
Ambivert	18.888	1.409	15.761	2.467
Introvert	19.500	.798	16.812	2.455
High-neuroticism	19.416	.668	15.894	2.078
Mid-neuroticism	18.625	1.408	16.500	2.534
Low-neuroticism	19.200	1.151	16.000	2.903
Labile-extraverts	18.455	1.507	15.100	2.331
Labile-introverts	19.333	.866	16.471	1.663
Stable-extraverts	19.150	1.136	15.500	2.877
Stable-introverts	19.375	.916	17.000	3.000

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